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Analysis of Transport Through a Fault Using Transfer Functions

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Understanding flow and transport in unsaturated fractured rock (i.e., matrix and fracture flow, and fracture-matrix interactions) is important for performance assessment and the design of the proposed radioactive waste repository at Yucca Mountain, Nevada. A key factor affecting performance of the proposed repository is the transport of radionuclides through unsaturated fractured rock that lies between the repository horizon and water table located ~300 m below. Of particular importance is the need for an understanding of diffusive mass transfer between high-permeability, advection-dominated domains and low-permeability domains.

An *in situ* field experiment was conducted in the Exploratory Studies Facility at Yucca Mountain, Nevada to examine flow and transport in the vicinity of a fault located in unsaturated fractured rock. This experiment involved the release of ~75,000 liters of ponded water over a period of 14 months directly into a near-vertical fault located in the fractured welded tuff of the Topopah Spring Tuff unit. Seepage rates were monitored in a large cavity (niche) excavated 20 m below where the water was released along the fault. Seven months after water was introduced, two conservative tracers (pentafluorobenzoic acid [PFBA] and bromide) were simultaneously released along the fault over a period of nine days. After the release of the tracers, seepage water was continuously collected from three locations in the niche and analyzed for the injected tracers.

The results from this field experiment demonstrate that flow and transport near a fault located in unsaturated fractured rock is complex due to mechanisms such as dynamic flow behavior. Continuum-based models may not be applicable when these types of mechanisms affect flow and transport. Measured breakthrough curves from this field experiment are analyzed using transfer functions as an alternative to the continuum-based models, and the applicability of using transfer functions to describe transport in the vicinity of a fault is evaluated.

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